

Scope of Ergonomics: Case Study of Academia and Industry in Bangladesh

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Abstract

Ergonomics is at the heart of the Fourth Industrial Revolution (IR4), where seamless human-machine interaction drives technological progress. As Bangladesh undergoes industrial transformation — though at a slower pace than global leaders — embracing ergonomics is key to improving workplace safety, efficiency, and productivity. Given the country's reliance on labor-intensive industries, integrating ergonomic principles is not just beneficial; it is essential

for worker well-being and long-term sustainability. This paper explores the role of ergonomics in Bangladesh from two perspectives: academia and industry. Ergonomics has been implemented in curriculums across Bangladesh, with academic research in ergonomic solution space continuing to develop. On the other hand, some businesses have begun adopting ergonomic practices, but a significant gap remains in structured implementation, especially in sectors where workplace safety is a critical concern. By examining research, and industry trends, this study also underscores the importance of ergonomics in shaping Bangladesh's industrial future. A deeper understanding of the country's ergonomic landscape will be vital for improving workplace conditions and positioning Bangladesh as a competitive player in the global economy. This paper includes (i) the Importance of ergonomics research in Bangladesh (ii) State of academic research on ergonomics in Bangladesh (iii) the Application of ergonomics in different industries throughout Bangladesh.

Keywords

Ergonomics, Academia, Industry, Safety, and Industry 4.0.

1. Introduction

The term “ergonomics” originates from the Greek words “ergon” (work) and “nomoi” (laws), essentially meaning the science of work. First coined by Wojciech Jastrzebowski in 1858, ergonomics has since developed into a multidisciplinary field that integrates principles from biomechanics, psychology, physiology, and engineering to design work environments that enhance human well-being and productivity (Helander, 2006; Sanders & McCormick, 1993). The discipline gained recognition during World War II when researchers focused on optimizing human interaction with military equipment, and it has since expanded to influence industrial design, workplace safety, and human-machine interaction across various sectors (Bridger 2008; Ergoweb 2025). Although many claim that ergonomics emerged as a field in the 1950s, even in the Stone Age, pre-civilized humans were crafting hand tools tailored to the user and task. About 2.8 million years ago, the genus Homo and the first stone tools appeared. For the next million years, technology and humans co-evolved, with more advanced tools providing access to safer surroundings and abundant food sources, thus fostering brain development (Ambrose, 2001; Hancock, 2000). Nonetheless, due to the swift progress of technology, human limitations have become increasingly apparent — particularly as robots have gained higher intelligence and humans have taken on the role of supervisory controllers responsible for monitoring, planning, and diagnosing (De Winter & Hancock 2021).

The expression “Fourth Industrial Revolution” refers to a considerable and transformative change in the functioning of society, economies, and industries as a result of technological advancements. It is termed a "revolution" due to its embodiment of a basic transformation in our living and working practices, similar to past industrial revolutions throughout history (Schwab 2017). The defining feature of IR4 is the merging of biological, digital, and physical systems, which has led to a heightened dependence on automation, robotics, and artificial intelligence. The advancement of technology and industry, with the emergence of the IR4, has made human-robot interactions vital in the fields from manufacturing assembly to workstation design to even agriculture, ergonomics is likely to be the vanguard discipline for further research (Benos et al.2020; Cardoso et al. 2021; Gualtieri et al. 2021). This is prompting more dialogues about ergonomics and human factors that maximize efficiency with increasing emphasis on optimizing the human-machine interaction, but limit cognitive and physical stress. This transition raises worries regarding workplace design, safety, and the well-being of workers, which encompasses ergonomic considerations in human robot collaboration, data visualization, and remote work settings (Coetzee 2019). Hence the advent of the Fourth Industrial Revolution (IR4) has made ergonomics more crucial than ever.

Whilst most non-developing nations experienced a near linear progression of industrialization i.e., successive industrial revolutions taken place throughout the country, most post-colonial developing nations did not progress as such. Especially Bangladesh, which experienced two back-to-back liberations, industrialization of different magnitude was phased in different parts and sectors of the country. That is to say, while the central region was more caught up to the ongoing IRs, the rest of the regions did not; and even in the central region of Bangladesh, different IRs took place based on the area the particular community or entrepreneurial body implemented. This lack of homogeneity essentially created a strata wherein more labor-intensive industries offered the least risk for investors. But still, like most developing countries, Bangladesh depends on the manufacturing of products to be delivered to foreign companies. Therefore, if Bangladesh can develop the management of its manufacturing and chain productions, the current rate of unit output would be substantially increased, a strong indicator that Industry 4.0 is crucial for these countries to move forward (M. D. Hossain et al. 2018).

1.1 Rationale Behind the Study

Thus, due to the more complicated scenario Bangladesh has been put into, there is a gap in the total comprehension of ergonomics breadth in Bangladesh's academic and industry alike. Understanding the status quo is fundamental as it provides a benchmark for evaluating current practices and identifying gaps that require attention enabling targeted solution formulation. Defining the scope and studying the existing conditions in any field ensures that new investigations and solutions are built upon proper grounds, promoting meaningful contributions, increasing the likelihood of success, and preventing redundancy (Mirza et al. 2013). This is particularly relevant in the situation of ergonomics in Bangladesh, where assessing the present state of ergonomics itself would provide necessary gap analysis to researchers to develop targeted interventions. Without a clear understanding of the status quo, research efforts risk being misdirected, leading to inefficient resource allocation and limited real-world impact.

1.2 Objective and Value of the Study

Assessing the status quo of ergonomics in Bangladesh is crucial for her future advancement and adoption of IR4 throughout the nation. Without a clear understanding of where the discipline stands currently in local academia and industry, it becomes challenging to address gaps, propose effective policies, and drive innovation. This study seeks to address this knowledge gap by exploring ergonomics from both academic and industrial viewpoints through an analysis of existing research and industry trends. This study intends to present an overview of the ergonomic landscape in Bangladesh and to spotlight areas for enhancement.

2. Literature Review

Bangladesh being a developing country is at the similar disadvantage as its peer developing countries, with policy implementation not producing enough research (publications) benchmarked to its developed peers (Kipo-Sunyezi, 2023). Exacerbated by the general lack of funding and commitment to Research and Development (R&D) both at a governmental and corporate stage, this created a situation where most R&D performed even by the "more R&D focused" companies to be reactive than proactive. This systematically created a situation where Bangladesh generally contends with serious ergonomic issues that frequently lead workplace injuries, chronic occupational health problems, and long-term musculoskeletal disorders (MSDs) (Bayzid et al. 2019; A. Hossain et al. 2018; M. D. Hossain et al., 2018; Rahman et al. 2019).

Despite its strata-ed industrial progress, Bangladesh also faces challenges in aligning with global IR4 standards in its most industrialized regions (Abdin 2019; Rumi 2020). Some industries, particularly the ready-made garments (RMG) sector, have incorporated ergonomic improvements due to international labor regulations and global pressure (Ahmed, 2017). There also has been efforts to shift to a green manufacturing and industry (Reza et al. 2017). However, industries such as construction, transportation, and small-scale manufacturing/service industries often lack systematic ergonomic policies leading to higher chance of MSDs and lower amount of safety (Akter et al. 2016; M. D. Hossain et al. 2018; Muhammad et al. 2013; Musa et al. 2024).

This discrepancy highlights the need for greater proactive research in ergonomics that addresses the unique industrial and geographical scenario of Bangladesh, which would be most effective way of proper growth over the current reactive approach to research (Mudambi & Swift 2011). But this must be followed by implementation, policy intervention, and awareness in all aspects to ensure Bangladesh's industrial sectors benefit from ergonomic advancements. While initially frustrating to implement, corporations are to benefit for adopting corporate social responsibility (CSR) as studies regularly show a greater degree of growth to the corporation itself in some manner (Fatima & Elbanna 2023; Kuratko et al. 2014).

3. Methodology

This study followed a picked procedure of analyzing twenty-five papers published in the last few years i.e., between 2019 and 2024 (generally). This specific approach was opted to gain a clear understanding of how ergonomics is currently researched and applied across different industries in Bangladesh. The papers were analyzed and abridged to gain a more comprehensive understanding of the current workspace ergonomic researchers are trying to work with. For a quantitative understanding of this workspace, the keywords of each paper were collected, compiled, and interpreted to get a more visual conception of the path Bangladeshi ergonomics research is pursuing.

4. Discussion

4.1 State of Academic Research on Ergonomics in Bangladesh

Ergonomics in academia is still in its developmental stage in Bangladesh: despite the inclusion of it in engineering and design curricula in Bangladeshi universities, the volume of research output is still limited compared to global benchmarks. While global research in ergonomics has advanced significantly, integrating fields such as biomechanics, cognitive science, and human-computer interaction, Bangladesh's academic contributions remain limited in both volume and scope. However, there has been a growing interest in the discipline, particularly within engineering faculties and public health research.

Table 1. List of HF/E courses in universities across Bangladesh, along with the respective department

University	Department	Course/Program
Shahjalal University of Science and Technology (SUST)	Department of Industrial and Production Engineering (IPE)	- Ergonomics and Industrial Safety (IPE 331) - Ergonomics Sessional (IPE 332)
Shahjalal University of Science and Technology (SUST)	Department of Architecture	Ergonomics (ARCH 601)
Bangladesh University of Engineering and Technology (BUET)	Department of Computer Science and Engineering (CSE)	- Human Computer Interaction (CSE425) - Advanced Human Computer Interaction (CSE6606)
Bangladesh University of Engineering and Technology (BUET)	Department of Industrial and Production Engineering (IPE)	Ergonomics and Safety Management Sessional (IPE 408)
Ahsanullah University of Science and Technology (AUST)	Department of Industrial and Production Engineering (IPE)	- Ergonomics and Productivity Engineering (IPE 3201) - Ergonomics Lab
Ahsanullah University of Science and Technology (AUST)	Department of Mechanical and Production Engineering (MPE)	Ergonomics and Productivity Engineering
Khulna University of Engineering and Technology (KUET)	Department of Industrial Engineering and Management (IEM)	- Human Factors Engineering and Safety Management (IPE 4219) - Ergonomics Lab
Military Institute of Science and Technology (MIST)	Department of Industrial and Production Engineering (IPE)	Ergonomics and Safety Management (IPE 317)
Islamic University of Technology (IUT)	Department of Mechanical and Production Engineering (MPE)	Human Factors and Ergonomics
Bangladesh University of Textiles (BUTEX)	Department of Apparel Engineering	Industrial Engineering (AE 481) focusing on ergonomics
Bangladesh University of Health Sciences (BUHS)	Department of Occupational and Environmental Health	- Bachelor of Public Health (BPH) in Occupational & Environmental Health & Safety - Master of Public Health (MPH) in Occupational Health & Safety

In Bangladesh, institutions such as the Shahjalal University of Science and Technology (SUST), Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), and etc. extensively offer courses that introduce ergonomic principles, human factors engineering, and workplace safety. These universities have incorporated ergonomics into their curricula, primarily within the departments of Industrial and Production Engineering (IPE), Architecture, Mechanical Engineering, and Occupational Health Programs. Further detail can be found in the following Table 1.

From Table 1, we get a consensus that there exists a trend of offering courses related to HF/E to IPE or Architecture, but less emphasis to other departments. This means that despite these efforts, ergonomics research remains largely confined to academic coursework to particular subjects, with limited interdisciplinary collaboration even being possible at the first place.

This essentially has given birth to a situation where research output in the field of ergonomics in Bangladesh is relatively sparse. In Figure 1 a broad breakdown of ergonomics-related research is illustrated, with the Figure 2 offering a total breakdown. From both of these charts we infer, existing studies primarily focus on musculoskeletal disorders among workers, and workplace safety in labor-intensive industries such as readymade garments (RMG) and manufacturing. Whilst some studies have investigated occupational health safety (OHS), and key insights of postural analysis in local industries; yet comprehensive research in emerging ergonomic trends — such as digital ergonomics, IR4 and human-machine interaction (HMI) — remains underdeveloped.

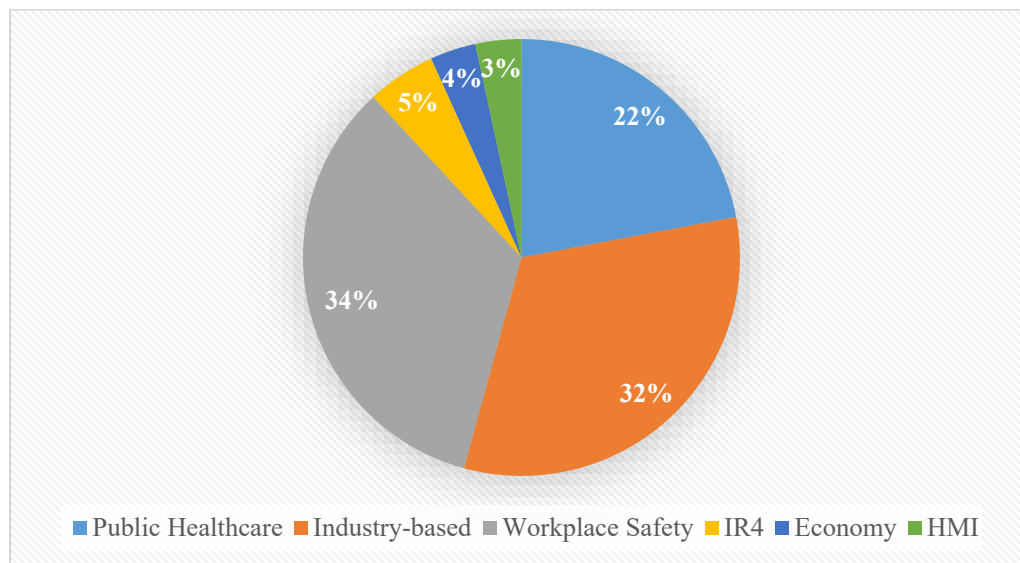


Figure 1. Broad Breakdown of Ergonomics-related Research in Bangladesh

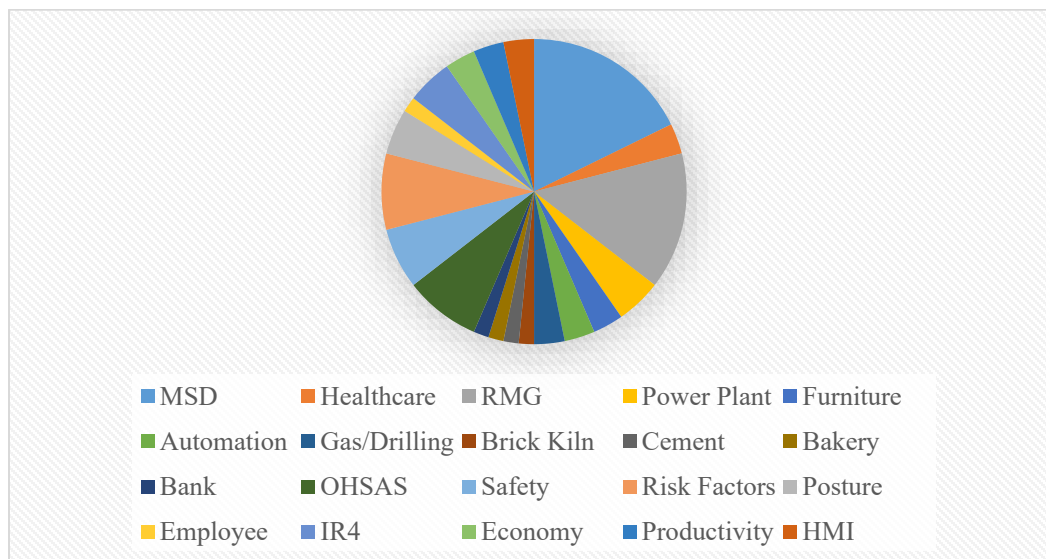


Figure 2. Total Breakdown of Ergonomics-related Research in Bangladesh

4.1.1 Proposed Solutions

For ergonomics to progress as a discipline in Bangladesh, it is essential to strengthen academic research across universities in Bangladesh which necessitates interdisciplinary collaboration, increased funding, and industry partnerships. But to that, more universities, and departments such as CSE, ME (Mechanical Engineering), MTE (Mechatronic Engineering), Architecture etc. must have some degree of human factors and ergonomics integrated. With it greater deal of resources must be allocated in the fields of ergonomics collaborating with IR4, digital ergonomics, HMI etc. alike for Bangladesh to get a competitive advantage in industrial advancements.

4.2 Application of Ergonomics in Different Industries Throughout Bangladesh

The application of ergonomics in Bangladesh's industries varies significantly across sectors, with some industries adopting ergonomic principles due to international compliance requirements, while others continue to operate with minimal ergonomic considerations. There also persists an asymmetrical research in-between all the industries as can be seen in Figure 3, where it is visibly clear that most R&D efforts go over to RMG.

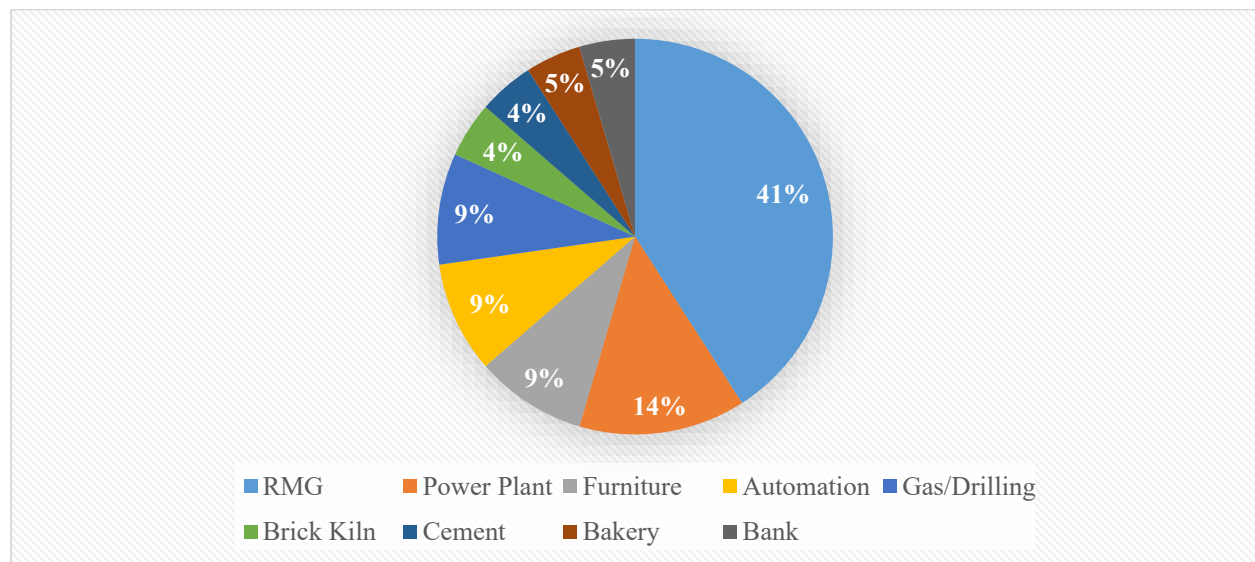


Figure 3. Breakdown of Ergonomics-related Research on The Basis of Industry

The Ready-Made Garments (RMG) sector is the backbone of Bangladesh's economy contributing 84.58% to her total exports during the fiscal year 2022-2023, with 10.35% contribution to the country's GDP in 2023 (Hasan et al.2025). There being some degree of safety policies being integrated in factory floors to international labor laws and compliance with global buyers' standards, with many factories adopting ergonomic workstation designs, improved seating arrangements, and implemented training programs to reduce repetitive strain injuries. Despite this, most medium-scale factories, and third-party buyers (B2B) have yet to implement a widespread adoption of ergonomic and safety principles. This has led to high amount of worker fatigue and greater likelihood of musculoskeletal disorders in workers (Bayzid et al. 2019; M. D. Hossain et al. 2018). Alternative ergonomic workstation designs have been proposed to combat the poor work posture onset by the status quo job-spaces (Samad et al. 2019). Critical factors related for implementing safety measures in RMG outlines to policymakers the potential solution space for enforcing ergonomic principles in factories (Bari et al. 2022; Shahriar & Milki 2023).

The heavy-duty manufacturing sector in Bangladesh encompassing industries such as automobile, shipbuilding, cement, and steel, has historically lagged behind in the adoption of ergonomic practices in the factory floor. Without appropriate ergonomic measures, workers frequently face physically taxing work, extended periods of standing, and dangerous environments – leading to higher risk of musculoskeletal disorders (Akter et al. 2016). While non-methodic attempts have been made to incorporate automation and redesign workspaces to minimize manual lifting and repetitive motion injuries, a considerable gap persists in the systematic approach to eliminate such issues through ergonomic principles.

In Bangladesh, the construction sector is one of the most neglected in terms of ergonomics, with workers often performing physically demanding tasks without proper attention to posture, load distribution, or the risks of repetitive strain. The problem is aggravated by insufficient awareness and regulatory enforcement, resulting in elevated workplace injury and MSD rates (Muhammad et al. 2013). This very same issue can be seen in the extended construction sector consisting of brick kiln and cement factories, where workers are generally more susceptible to MSDs and occupational safety hazards (Iqbal et al. 2023; Islam et al. 2023).

The furniture industry generally involves both manual craftsmanship and mechanized production, where ergonomic interventions can improve worker effectiveness and safety; while better design, posture support, and optimized tool layouts in furniture can help reduce musculoskeletal disorders among workers (Sakib et al. 2023). Furthermore, the growing demand for ergonomic furniture, such as adjustable chairs and desks, is creating a new market within the industry itself, highlighting the role of ergonomics in both production and product design. The petroleum, gas-field and mining sectors entail very demanding physical work, frequently under harsh conditions. While a more dangerous sector to work previously, in the last decade the safety conditions have improved a lot with the findings that 78% or 80% of workers felt safe with risk sources or work tasks in three petroleum fields in Bangladesh (Md. N. Hossain & Howladar 2022).

4.2.1 Proposed Solutions

In Bangladesh, the application of ergonomics in various sectors is inconsistent, mainly because of insufficient awareness, regulatory enforcement issues, and concerns about costs. With a focus on regional (native) research on ergonomics, all of this factors can be mitigated in a short time. Nonetheless, as industrial modernization and global integration advance, companies are albeit slowly but still acknowledging the advantages of ergonomic interventions in mitigating workplace injuries and enhancing productivity in workers. To close the existing gaps and foster a healthier, more productive workforce in Bangladesh's industrial sectors, a structured approach to ergonomics — bolstered by policy measures with interventions, industry standards, and academic research — is essential.

5. Conclusion

Bangladesh is steadily advancing in industrial modernization, particularly within the framework of the Fourth Industrial Revolution. As industries in Bangladesh grow, especially as it automates more, the need for ergonomic principles in workplaces is becoming more evident. This study explores the importance of ergonomics in Bangladesh, and examining the status quo of it in both academic research and real-world applications across different sectors.

The present scenario is a mixed one: while certain industries especially the ready-made garments sector have made progress in adopting ergonomic practices due to international compliance requirements; others, such as construction and manufacturing, still lag behind in implementing ergonomic and safety principles. Academia has certainly come miles ahead and contributing more to the field of ergonomics as compared to its previous decades, but there remains a significant gap between theoretical advancements and practical implementation. Many industries still operate with outdated workplace designs and practices, leading to increased health risks for workers and decrease in productivity.

Our findings highlight the importance of prioritizing ergonomics in Bangladesh's industrial landscape. Improving workplace conditions through ergonomic integration can reduce injuries, enhance efficiency, and support long-term economic growth. Moving forward, a structured approach involving research, education, and policy reforms will be crucial in ensuring that Bangladesh builds a sustainable and worker friendly industrial environment.

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